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APPARATUS FOR ALIGNING MULTIPLE PROJECTED IMAGES IN COCKPIT DISPLAYS

FIELD OF THE INVENTION

The present invention generally relates to large area, or panoramic, cockpit displays and even more particularly relates to such displays having multiple image projectors illuminating a common viewing screen.

BACKGROUND OF THE INVENTION

In the past, designers of avionics displays have endeavored to provide larger and larger display devices to better provide for enhanced situation awareness for flight crews. The use of projection displays in cockpits is gaining many followers because of their recognized ability to provide large area, or panoramic, displays. One method for creating large, high resolution displays is to illuminate a single viewing screen with multiple image projectors. These multiple projector images may be arranged as contiguous non-overlapping, partially overlapping, or totally overlapping image segments. All such configurations may be referred to as tiled image displays. The resulting large image, being comprised of several smaller images, may be referred to as a composite image. While these displays have many advantages, they also have significant drawbacks.

Tiled projection displays must maintain a high degree of alignment precision to provide the superior performance necessary for avionics enhanced situation awareness displays. However, the cockpit is not a mechanically static or benign environment. In-flight turbulence, forces of impact upon landing and other forces resulting from maneuvering the aircraft can be substantial, especially for smaller aircraft and most especially, for fighter aircraft used in operation on-board aircraft carriers. These forces can cause mechanical displacement of the projectors, viewing screens, and other components. Normal variations in aircraft temperature can also cause the projectors, or their images, to move.

Consequently, there exists a need for dynamic alignment of tiled projection displays.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide tiled projection displays having a superior image alignment characteristic.

It is a feature of the present invention to utilize a multi-axis adjustable beam deflector.

It is an advantage of the present invention to optically align tiled projected images.

It is another feature of the present invention to include a static compensator.

It is another advantage of the present invention to reduce aberration corrections required for unequal optical path lengths.

It is yet another feature of the present invention to include electro-mechanical gimbal drive motors and gimbal angle sensing devices.

It is yet another feature of the present invention to include electro-optical sensing devices for detecting and measuring undesired image displacement.

It is yet another advantage of the present invention to provide a fully functional tiled projection display system which is capable of in-flight adjustment to compensate for misalignment.

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It is yet another advantage of the present invention to provide misalignment correction in an automated manner that eliminates manual alignment operations.

It is still yet another feature and advantage of the present invention to provide a means for mechanically-isolated, independently mounted projectors and display screens.

It is still yet another advantage of the present invention to provide for easy mounting of aligned systems.

The present invention is an apparatus and method for aligning tiled projection images, which is designed to satisfy the aforementioned needs, provide the previously stated objects, include the above-listed features and achieve the already articulated advantages. The present invention is carried out in a "misaligned image-less" manner in a sense that the time that a misalignment condition is allowed to exist has been greatly reduced.

Accordingly, the present invention is a tiled projection display system which utilizes a multi-axis adjustable optical beam deflector.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention may be more fully understood by reading the foregoing description of the preferred embodiments of the invention, in conjunction with the appended drawing wherein:

The FIGURE is a simplified schematic diagram of a tiled projection image system of the present invention, showing light emanating from the projectors and beam deflectors as solid lines and with the dotted lines used to show a viewing angle of a camera. The projectors illuminate the viewing screen, while the camera simultaneously views the resulting composite image.

DETAILED DESCRIPTION

Now referring to the drawing wherein like numerals refer to like matter throughout, there is shown a system of the present invention, generally designated **100**, having a first projector **110** and a second projector **120**, which may be any type of projector used for projecting portions of a tiled image, such projectors being well known in the art. The description herein focuses upon a multiple projector system which is believed to be a common design choice. However, it is understood that use of a single projector is also contemplated by this invention, and the multi-projector description is merely an example of various possibilities. Projectors **110** and **120** generally emit light to form a portion of an image **160** and **170** respectively. Images **160** and **170** may be projected on to various types of viewing surfaces which are well known in the art, such as a diffuser disposed in the instrument panel of an aircraft. The diffuser or other optical device is chosen to provide a wide or tailored viewing angle to facilitate in some designs a simultaneous cross-cockpit viewing from multiple members of the flight crew and in others, a highly focused high gain display. In the present invention, we show a tiled display with separate viewing surfaces for images **160** and **170**. However, in some circumstances, it may be desirable to superimpose both images onto one screen. The images may be identical, and the superimposition may provide for redundancy and increased brightness, etc. The present invention is intended to include superimposed displays despite the references herein to tiled displays. Tiled displays are merely an example of various types, including superimposed and others. Disposed between projectors **110** and **120** and their respective viewing surfaces are beam deflectors **112** and **122**